mirror **116** rotate about mechanical pivot **16**. This eliminates the need for first and second fixed mirrors **38** and **68** shown in FIG. **1**. The positions of lenses **54** and **108** are determined by their selected focal lengths and the distance of the optical path taken by the light beam. Standard formulas for calculating focal, object and image distances for multiple lens systems can be used. Lenses **54** and **108** can be placed in the beam path between mirror assemblies **56** and **42** or between mirror assembly **42** and probe assembly **26**. Before scanning begins the light beam is adjusted onto cantilever **28**. During scanning, lenses **54** and **108** will cause the beam will follow cantilever **28** as it rotates about mechanical pivot **16**.

FIG. **3** shows a further alternate method. Holder **128** supports laser **32**. Diverting mirror **116** rotates with holder **128**. Light from laser **32** is routed to cantilever **28** by refraction at lens **54** and by reflection from mirror assemblies **42** and **56**. The beam reflects from cantilever **28** and impinges on photodiodes **78** and **80**.

FIG. **4** shows how pentagon prism **130** is used to eliminate fixed mirrors **38** and **68** shown in FIG. **1**. Prism **130** also eliminates diverting mirror **116** shown in FIG. **2**. A pentagon prism has the property that it does not pervert the image as does a single plane mirror. Lens **54** causes the beam to follow cantilever **28** as it rotates around pivot **16**. The reflected beam impinges on photodiodes **78** and **80**.

FIG. **5** eliminates compensation lens **54** and the adjustable mirrors **44** and **58** of FIG. **1** by interposing adjustable spherical mirror **136**. Mirror **136** is adjustable around vertical axis **140** and lateral axis **142**. Probe mirror **144** rotates about pivot **16**. Spherical mirror **136** compensates for the nearly spherical rotation of laser **32**, probe mirror **144** and probe assembly **26**. Pentagon prism **130** is used for conveniently redirecting path **126**. For a generalized spherical mirror the radius of curvature is found from standard formulas relating the radius, image distance, and object distance. For light rays with an angle of approximately 0.2 degree or less, the radius of curvature is calculated with sufficient accuracy using the following formula:

$$\frac{2}{R} = \frac{1}{s} + \frac{1}{s'},$$

where R is the radius of curvature of a spherical mirror, s is the distance from the object to the mirror, and s' is the distance from the mirror to the image. The appropriate sign conventions must be followed when making the calculations.

Summary, Ramifications, and Scope

With my scanning force microscope it is possible to adjust the laser beam onto the cantilever without mechanical linkages to either the lateral or vertical driver nor to any part that moves with the lateral or vertical driver. The light beam continues to track the motion of the cantilever as it scans over the surface of the sample. Further, by using low mass components the mass of the moving elements is reduced and the system is able to scan at a faster rate. The implementation is uncomplicated and straight forward.

While the description given above is quite specific and detailed it should not be considered to limit the scope of the invention but should instead be considered as only describing some examples,of the invention. There are many alternate variations of the invention. For example, the lenses shown are double concave and double convex. They can be piano convex, piano concave, achromatic, cylinder, meniscus or graded index lenses. Roof prisms, porro prisms and right angle prisms can be substituted or added to the light beam path. Optical wedges can be used to refract the beam. The plane mirrors can have slightly curved surfaces such that they act similar to the compensation lenses shown. Further, optical fibers can be used to redirect the light beam.

The methods for rotating the adjustable fixed frame lenses and mirrors can employ lead screws, differential thread lead screws, or piezo-actuators or combinations of these.

The scanning mechanism can take many forms. The vertical and lateral drivers can be piezoelectric blocks, stacks, tubes or bimorphs. The vertical and lateral drivers can be actuated by piezoelectric devices or by magnetic or magneto strictive devices. The vertical and lateral drivers can be combined into one device such as a single piezoelectric tube that can create relative motion in the x, y and z direction with respect to the sample surface.

The light source can be a laser, a light emitting diode, or an incandescent source. The light detectors in the examples are photodiodes, but there are other types of devices such as phototransistors that can detect light. If an array of four or more light detecting devices is used, the lateral motion of the beam as well as the vertical motion can be detected.

The output signal from the difference amplifier can be processed to form a signal which actuates a motor which in turn drives the adjustable mirror assemblies mounted in the fixed reference frame. This makes possible automatic adjustment of the adjustable assemblies.

The scanning force microscope described here can operate with the sample submerged in fluids. Further, the microscope can operate by oscillating the cantilever and detecting some parameter of the oscillation such as the amplitude, frequency, or phase change in the electrical output signals as the oscillating cantilever approaches the proximity of the sample surface. The oscillating cantilever may actually come into intermittent contact with the sample surface.

In the examples given a stylus is used to create a bending action of the cantilever. However, other types of probes, such as magnetic probes, can be used to bend the cantilever.

Thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.

I claim:

1. A scanning force microscope comprising:

(a) a light source;

(b) a cantilever;

(c) a scanning means for moving said light source and said cantilever relative to a sample;

(d) an optical assembly comprising at least one optical component in the frame of reference of said sample;

where said light source directs a light beam onto said optical assembly, and said assembly redirects said light beam onto said cantilever.

2. The scanning force microscope of claim **1** where said light source is a laser.

3. The scanning force microscope of claim **1** where said scanning means includes at least one piezoelectric tube.

4. The scanning force microscope of claim **1** where said cantilever deflects as a result of the topography of said sample.

5. The scanning force microscope of claim **1** where said cantilever deflects as a result of the magnetic fields of said sample.

6. The scanning force microscope of claim **1** where said optical assembly includes at least one lens and at least one adjustable mirror.

7. The scanning force microscope of claim **1** where said optical assembly includes at least one prism.